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A Comprehensive Study on the Agronomic and Technological Responses of Different Chamomile (*Matricaria recutita* L.) Varieties at Diverse Sowing Times

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ABSTRACT

In this study, it was aimed to determine the effects of different sowing times and different varieties of German chamomilla (*Matricaria recutita* L.) on agronomic and technological characteristics. The study was conducted in experimental fields of the Department of Field Crops, Faculty of Agriculture in Adnan Menderes University. Two different tetraploid *Matricaria recutita* L. (Bodegold and Zloty Lan) cultivars were used for this study. Zloty Lan was provided by Germany and Bodegold was provided from Atatürk Central Horticultural Research Institute. The trial was conducted according to a split plot experimental design with 4 block. Factors consist of 5 sowing times as main plots (1 October, 15 October, 1 November, 15 November, 1 December) and 2 genotypes as subplots (Bodegold and Zloty Lan). The effect of sowing times and genotypes was found statistically significant on fresh flower yield. The highest flower yield was found 61.61 kg da^{-1} . The average values for plant height ranged from 45.43 to 55.20 cm, flower diameter ranged from 25.24 to 27.53 mm, biomass ranged from 130 to 332.3 kg da^{-1}, fresh flower yield ranged from 19.74 to 61.61 kg da^{-1} , drug herb ranged from 35.5 to 73.5 kg da^{-1} , drug flower ranged from 7.4 to 13.3 kg da^{-1} , essential oil content ranged from 0.025% to 0.083% and essential oil yield ranged from 0.020 to 0.090 l da^{-1}. The primary constituents of essential oil have been discovered as bisabolol oxide a and bisabolene oxide.

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Introduction

Matricaria recutita L. is a diploid plant that is categorized under the *Asteraceae* family and is commonly utilized for its therapeutic properties. The origins of this plant can be traced back to the Near East, South and East Europe (Franke and Schilcher, 2005; Lubbe and Verpoorte, 2011). Chamomile, known by its common name, has been used in herbal remedies for thousands of years and was acknowledged in ancient civilizations including Egypt, Greece and Rome (Singh et al., 2011). This crop is considered important by Germany because of its significant contributions to the pharmaceutical, cosmetic and food industries (Wagner et al., 2005).

Chamomile is a plant with medicinal and aromatic properties. Its white flowers bloom between May and August. Special fragrance during this period and the hollow yellow flower base distinguishes it from other wild daisies. Worldwide, three main species of this plant are of high commercial value, these are *Matricaria chamomilla* L., *Chamaemelum nobile* and *Ormenis multicaulis*. Among these three species, chamomile is particularly having high commercial value (Nathan, 1999).

The medicinal use of chamomile is quite common. Especially the flower part is used to make medicines. The World Health Organization has published many medical articles about the health benefits of chamomile. Chamomile extracts are used to treat many ailments, such as skin problems, mouth infections, bacterial infections and many other diseases. Many licensed medicines in countries such as Germany contain chamomile extracts. It is also known to be effective against digestive system problems. It grows naturally in Turkey, especially in the Marmara, Aegean, Thrace and Southwestern Anatolia regions. The medicinal and aromatic properties of the plant support its widespread use in traditional and modern medicine (Kırımer, 2010).

The essential oil is extracted from the flowers by steam distillation or solvent extraction, with yields ranging from 0.24 to 1.90% (Salamon et. al. 2010). Coumarin, flavonoids, α-bisabolol, bisabolol oxide A and B, chamazulene, sesquiterpenes, spiroethers and other components such as tannins, anthemic acid, choline, polysaccharides and phytoestrogens are the active components in German chamomile (*Matricaria recutita* L.) (McKay et. al. 2006).

During the extraction of the essential oil, chamazulene is generated through the breakdown of chemicals such as sesquiterpene lactones. These compounds, which are originally colorless, enter the essential oil together with water vapor. Consequently, chamazulene is produced as a result of this process. Chamazulene gives a deep blue color to the oil and possesses potent anti-inflammatory properties. The medicinal effectiveness of chamomile is mostly determined by its chamazulene content. Pharmacies commonly sell mouth and throat sprays that have an impact on mucous membranes, particularly those made from medical chamomile, which are easily accessible overseas (Wang et al., 2020).

The chamomile, scientifically known as *Matricaria recutita* L., is highly valued for its comprehensive pharmacological characteristics and its long-standing use in traditional medicine. It is widely utilized in several European countries (Singh et al., 2011) due to its significant economic worth.

Recent studies have shown the importance of sowing timing in chamomile cultivation as it impacts both plant growth and quality. According to Moisiienko & Nazarchyk (2019), sowing times affect flowering time yield performance. Also, Ebadi et al. (2010) have found a correlation between the date of sowing time and the production of flowers, essential oil and the essential oil composition. According to these findings, chamomile cultivation can be greatly enhanced by carefully choosing the date of sowing. This indicates the significance of choosing the suitable sowing season to maximize chamomile cultivation in particular locales.

This study aimed to identify the appropriate cultivar and ideal sowing period for chamomile (*Matricaria recutita* L.) in the ecological circumstances of Aydın. Additionally, the study aimed to assess the variations in yield, essential oil content and essential oil components among different varieties.

Materials and Methods

This study was conducted in the experimental field of the Faculty of Agriculture Research and Application Farm at Adnan Menderes University during the 2014-2015 period. The experiment was established according to the split-plot experimental design with 4 replications, 5 sowing times (October 15, November 1, November 15, December 1, December 15) as the main plots and 2 varieties (Bodegold, Zloty Lan) as subplots.

Material

Bodegold and Zloty Lan, both tetraploid variants of *Matricaria recutita* L., were used as the material for the study. Zloty Lan seeds were obtained from Germany, while Bodegold seeds were obtained from Atatürk Horticultural Cultures Central Research Institute (Figure 2).

Methods

The procedure of sowing seeds was performed on October 15, 2014, November 1, 2014, November 15, 2014, December 1, 2014, and December 15, 2014. Within each plot, eight rows were established with a row spacing of 30 cm by using a marker, and seeds were manually sown in these rows (Figure 1).

The nitrogen fertilizer was divided into two equal portions, with one portion applied prior to sowing and the second portion applied around one month after sowing. In addition, Phosphorus fertilizer (P_2O_5) was incorporated into the soil during the sowing with a rate of 4 kg per decare. Irrigation was not conducted; water requirements were fulfilled only through precipitation. Weeds were manually removed by using a little hoe to prevent any harm to the plants.

Due to favorable germination and growth conditions in October and early November, the plants achieved a height of 8-9 cm for the first sowing time (15 October) and the second sowing time (1 November) reached a height of 3-4 cm before the winter season. The plants that sowed during the third, fourth and fifth sowing times only germinated before the winter season. Once the weather became warmer growth resumed in March 2015.

Harvesting was done in the 5th and 6th period when the white flowers were fully open. The plots were harvested when 80% of the flowers within them had reached this stage. Before harvesting, measurements were taken in the *Matricaria recutita* L. plots during the 5th and 6th stages. During harvesting, the crops were cut approximately 10cm above ground level.

Soil properties of the field where the experiment was conducted are shown in Table 1; The climate characteristics of the year in which the experiment was conducted are given in Table 2.

Throughout the study, various agronomic and technological aspects were measured.

Figure 1. Parcelization, preparation and some applications before sowing in the field

Figure 2. Tetraploid varieties with dense, white flowers and a large yellow flower button

Table 1. Soil characteristics of the field where the experiment was conducted

Soil	Value	Condition
Sand (%)	71.95	-
Silt (%)	11.33	-
Clay (%)	16.72	-
Structure	SL	Sandy Loam
Salinity (%)	0.044	Low
pH	8.4	Alkali
Lime (%)	3.89	Chalky
Org. Matter (%)	1.21	Low
P (ppm)	20.15	High
K (ppm)	176	Low
Ca (ppm)	2978	High
Mg (ppm)	584	Very High
Na (ppm)	101	Average
Fe (ppm)	19.8	High
Zn (ppm)	1.32	Adequate
Mn (ppm)	5.92	Adequate
Cu (ppm)	1.5	Adequate
B (ppm)	1.35	Adequate

Table 2. Climate data for the year the experiment was conducted

Months	Rainfall (mm)	Temp (°C)	Humidity (%)
January	90.6	9.7	93
February	32	9.6	88
March	64.8	11.7	78
April	54.6	15.4	74
May	8	20.4	63
June	68	24.6	57
July	6.2	27.1	56
August	5.8	27.8	58
September	13.2	22.8	66
October	41	18.2	71
November	95.2	12.7	83
December	275	11.3	93
Total	754.4	-	-
Average	-	17.6	73.3

ADU Faculty of Agriculture, Meteorology Station

Agronomic Parameters

Days to Flowering (days): It was determined as the number of days between the sowing date and the flowering date (50% of the plot)

Plant Height (cm): Plant height was determined by measuring the length of 10 randomly selected plants from each plot from the level of emergence from the soil to the tip of the main stem of the plant.

Flower Diameter (mm): Flower diameter was measured by using a digital caliper from the flowers of 10 randomly selected plants from each plot.

Fresh Herb Yield (kg da^{-1}): After the plants were harvested about 10 cm above the soil surface, all above-ground parts were weighed and fresh herb yield per decare was determined over the harvested area.

Drog Herb Yield (kg da^{-1}): 1 kg sample of fresh herb was dried and weighed to determine the drying rate and this value was multiplied by the fresh herb yield to determine the yield of drog herb per decare.

Fresh Flower Yield (kg da^{-1}): The flower yield was determined in 2 kg sample taken from fresh herb and this rate was multiplied by the fresh herb yield and flower yield per decare was calculated.

Drog Flower Yield (kg da^{-1}): The drying rate was determined by drying and weighing the fresh flowers determined in 2 kg sample taken from fresh herb, and then this rate was multiplied by the fresh flower yield to determine the drog yield of flowers per decare.

Technological Characteristics

Essential Oil Content (%): The essential oil content of the flowers from each plot was determined by the volumetric method using the Neo-Clevenger apparatus.

Essential Oil Yield (l da^{-1}): It was found by multiplying the essential oil content obtained for each plot by the yield of the flowers.

Essential Oil Components: Determined by GC in the essential oil samples of each plot. Essential oil component analysis was carried out in the GC-MS device at Ege University Institute of Substance Toxicology and Pharmaceutical Sciences.

The data obtained in the experiment were analyzed separately for each trait by analysis of variance according to the split-plot experimental design, and the differences were determined using the F test. Analysis of variance was performed using TARIST package program. Statistically significant factors were grouped by LSD test. Factors that were not significant by LSD test were compared according to the mean table.

Results and Discussion

The duration of chamomile's (*Matricaria recutita* L.) flowering period is provided in Table 3. When analyzing the duration of time until blooming for various sowing periods, it is observed that both varieties present an equivalent number of days until flowering. However, variations in the number of days until flowering are obvious based on the different sowing timings. The longest duration for flowering was seen at 158 days for the first sown, which took place on October 15, 2014. By March 22, 2015, 50% of the plots had reached the flowering stage (Table 3). The shortest duration for flowering was observed at the fifth sowing period, which occurred on December 15, 2014. It took 130 days for the plants to flower, with 50% of the plots reaching the flowering stage on April 11, 2015.

According to height measurements of tetraploid cultivars of chamomile (*Matricaria recutita* L.) at various sowing intervals, the findings indicated that the influence of sowing time, variety and the interaction between sowing time and variety on plant height was not significant. The Zloty Lan variety exhibited the highest average plant height of 55.2 cm during the second sowing time, however, the shortest average height of 45.43 cm was seen in the Zloty Lan variety during the first sowing time. The height of the plants in the Bodegold variety ranged from 46.65 to 51.23 cm.

Mohammad et. al., (2010) stated that *Matricaria recutita* is a plant that reaches a height of 30-70 cm. In a study conducted by Arslan (2012), various chamomile varieties were investigated under Yalova ecological conditions. The results showed that the lowest plant height values were seen on December 23, while the highest height of 112.5 cm was recorded in the Bona variety. In a study conducted by Azizi (2007), it was discovered that the Goral and Bodegold cultivars had greater plant height measurements compared to the Germania and Bona cultivars. Rafieiolhossaini et al. (2010) found that the sowing time had a significant impact on the height of the plants. In their study, Hadi-Seyed et al. (2004) discovered that the sowing time had a significant impact on certain agronomic features, but did not have any effect on plant height. Salamon (2004) observed a variation in plant height, ranging from 45.43 cm to 55.20 cm, which can be related to variations in ecological conditions and the use of different cultivars.

When we compare flower sizes between two tetraploid cultivars of chamomile (*Matricaria recutita* L.) and the effect of sowing times, it was found that impact of sowing times, variety, and the interaction between sowing time and variety on flower diameter was not significant. The Bodegold variety had the largest average flower diameter of 27.53 mm at the 5th sowing period, whereas the smallest average of 25.24 mm was observed in the Bodegold variety at the 2nd sowing time. The Zloty Lan variety exhibited diameters ranging from 25.85 to 26.91 mm.

Mohammad et. al., (2010) found that the flowers of *Matricaria recutita* have sizes that vary from 15 to 30 mm. Rafieiolhossaini et al. (2010) observed that the largest flower diameter was achieved when the plants were sown on April 15th. Arslan (2012) discovered that sowing periods, November 10, November 30 and December 23 had a significant impact on the flower diameter of chamomile cultivars in the ecological conditions of Yalova.

In a study conducted by Azizi (2007), it was found that the sowing time had a significant impact on the diameter of flowers in four distinct cultivars of *Matricaria recutita*. Hadi-Seyed et al. (2004) highlighted that the sowing time had a substantial impact on agronomic characteristics, but did not have a statistically significant effect on the diameter of flowers. The values were higher than Rafieiolhossaini et al. (2010) and lower than those of Arslan (2012). This difference may be due to the fact that we have used tetraploid varieties while Rafieiolhossaini et al. (2010) used diploid varieties.

It was found that fresh herb yield (kg da^{-1}) was affected as statistically insignificant by sowing times, variety and sowing time x variety. The Bodegold variety had the highest yield, with an average of 332.3 kg da^{-1}. The lowest yield was obtained from the Zloty Lan variety at the 5th sowing time with 130 kg da^{-1}.

Table 3. Sowing times and days to 50% flowering of each sowing time.

	Sowing Time	50% Flowering	Days
1 S.T	15.10.14	22.03.2015	158 day
2 S.T	01.11.14	26.03.2015	146 day
3 S.T	15.11.14	05.04.2015	141 day
4 S.T	01.12.14	10.04.2015	131 day
5 S.T	15.12.14	11.04.2015	130 day

Table 4. Varience analysis results of measurements of varieties and different sowing times

Variance Sources	PH (cm)	FD (mm)	FHY (kg da^{-1})	DHY (kg da^{-1})	FFY (kg da^{-1})	DFY (kg da^{-1})	EO (%)	EOY (l da^{-1})
Sowing Time	6,089	3.606	22329.17	689.24	2781.489*	4.28	0.001	0.002
Error-1	1,986	3.008	17194.65	1402.40	527.797	45.07	0.001	0.002
Varieties	38,756	0.018	8932.36	174.93	649.557	15.02	0.002	0
STxVar	36,018	1.138	22371.61	1493.16	648.581	38.66	0.002*	0.004
Error	14,774	1.86	24571.16	1165.89	860.449	41.44	0	0.004
Total	28,372	2.356	20671.88	1297.90	930.665	37.31	0.001	0.003

PH: Plant height, FD: flower diameter, Fresh herbage yield, DHY: Drog herbage yield, FFY: Fresh flower yield, DFY: drog herbage yield, EO: essential oil content, EOY: essential oil yield.

Table 5. Mean values of plant height, flower diameter, fresh herbage yield and drog herbage yield of cultivars according to sowing times

	PH (cm)			FD (mm)			FHY (kg da^{-1})			DHY (kg da^{-1})		
ST	ZL	BG	Avrg.	ZL	BG	Avrg.	ZL	BG	Avrg.	ZL	BG	Avrg.
1. ST	45.43	48.55	46.99	26.79	27.31	27.05	332.3	202.7	267.5	60	35.5	47.75
2. ST	55.2	46.65	50.92	25.85	25.24	25.55	265.9	172.3	219.1	57.3	37.5	47.4
3. ST	50.8	47.1	48.95	26.12	25.94	26.03	204.1	193	198.55	72.4	72.8	72.6
4. ST	48.93	46.95	47.94	26.07	26.83	26.45	155.6	134.8	145.2	62.1	50.3	56.2
5. ST	49.05	51.23	50.14	26.91	27.53	27.22	130	212.2	171.1	40.3	73.5	56.9
Avrg	49.88	48.09		26.35	26.57		169.78	183		58.42	53.92	

PH: Plant height, FD: flower diameter, Fresh herbage yield, DHY: Drog herbage yield

Table 6. Mean values of fresh flower yield, drog flower yield, essential oil and essential oil yield of cultivars according to sowing times

	FFY (kg da^{-1})			DFY (kg da^{-1})			EO (%)			EOY (l da^{-1})		
ST	ZL	BG	Avrg.	ZL	BG	Avrg.	ZL	BG	Avrg.	ZL	BG	Avrg.
1. ST	74.40	48.80	61.61 a	12.20	7.40	9.80	0.06ab	0.08a	0.07	0.09	0.07	0.08
2. ST	44.50	34.00	38.49 ab	13.30	11.70	12.50	0.05ab	0.07a	0.06	0.08	0.08	0.08
3. ST	25.30	19.50	22.39 b	12.10	9.20	10.65	0.08a	0.04b	0.06	0.09	0.04	0.06
4. ST	20.70	18.80	19.74 b	9.70	9.30	9.50	0.03b	0.06ab	0.05	0.04	0.06	0.05
5. ST	18.20	23.20	20.69 b	8.10	11.20	9.65	0.03b	0.05ab	0.04	0.02	0.06	0.04
Avrg	36.62	28.86		11.08	9.76		0.05ab	0.06ab		0.06	0.06	

FFY: Fresh flower yield, DFY: drog herbage yield, EO: essential oil content, EOY: essential oil yield

Berimavandi et al. (2011) found no significant effect of sowing times on fresh herb yield in Calendula officinalis. Arslan (2012) found that sowing time significantly affected the fresh herb yield of chamomile cultivars in Yalova ecological conditions at different sowing times. The highest yield was obtained at the 1st sowing time with 4661.5 kg da^{-1} for Zloty Lan and 2586.2 kg da^{-1} for Bodegold. In our study, the highest fresh herb yield was obtained from the Zloty Lan variety at the 1st sowing time with 332.2 kg da^{-1}. This difference may be due to ecological differences.

The results show that sowing times, cultivar and sowing time x cultivar did not significantly affect the yields of drog herb. The highest average drog yield was 73.5 kg da^{-1} in Bodegold cultivar with 5th sowing time, while the lowest was 35.5 kg da^{-1} in Bodegold cultivar with 1st sowing time. The highest value was found 72.40 kg da^{-1} in Zloty Lan variety at the 3rd sowing time.

Arslan (2012) found that Bodegold drog yielded 879.4 kg da^{-1} at the 2nd sowing time, while Zloty Lan yielded 847.1 kg da^{-1} at the 1st sowing time. Berimavandi et al. (2011) reported that different sowing times did not affect the yield of Calendula officinalis. The difference between the studies may be due to climatic and soil conditions.

The sowing time x cultivar interactions on fresh flower yield were insignificant, but the effect of sowing times on this parameter was found significant. The average fresh flower yield of the 1st sowing time has the highest value with 61.61 kg da^{-1}, while the 4th sowing time has the lowest value with 19.74 kg da^{-1}. 1. Sowing time and 2. Sowing time has the highest values and within the same statistical group (Table 6). The highest average was obtained by the Zloty Lan cultivar with 1st sowing time, while the Bodegold has value that 48.80 kg da^{-1} 5th sowing time.

Previous studies have reported that sowing times have a significant effect on chamomile flower yield. Hadi-Seyed et al. (2004) found that sowing time (March 5, March 15, and March 25) affected the yield of fresh flowers, with yields of 213.2 kg da^{-1}, 181.4 kg da^{-1} and 169.9 kg da^{-1} respectively.

The findings revealed that the impact of sowing times, cultivar type and the interaction between sowing time and cultivar on drog flower yield was not statistically significant. Zloty Lan exhibited the highest average drog flower yield at the second sowing time, with 13.3 kg da^{-1}, while the lowest average yield was observed in the Bodegold cultivar at the first sowing time, with 7.4 kg da^{-1}.

When we compare the results with Hadi-Seyed et al. (2004), the drog flower yield values in our study were notably lower, suggesting potential influences from climatic and regional disparities. Furthermore, a decline in flower yield was noted with delayed sowing time for Zloty Lan but not for Bodegold. Despite no statistical variance in flower yield between the two cultivars, this lack of distinction may be attributed to inherent differences in the cultivars themselves.

Variance analysis results of essential oil content (%) of chamomile (*Matricaria recutita* L.) cultivars Zloty Lan and Bodegold at different sowing times were given in Table 5 and the mean values were given in Table 6.

When Table 6 is examined, it can be seen that the effect of sowing times and cultivars on essential oil content (%) was found to be insignificant, while the sowing time x cultivar interaction was significant at 5% level. The highest essential oil content (%) was 0.08% in Bodegold variety at the 1st sowing time and the lowest essential oil content (%) was 0.03% in Zloty Lan variety at the 5th sowing time. The highest value was obtained with 0.08% in Zloty Lan variety at the 3rd sowing time, while the lowest value was obtained with 0.04% in Bodegold variety at the 3rd sowing time.

Hadi-Seyed et al. (2004) investigated the impact of varying sowing times (March 5, March 15, and March 25) on the agronomic characteristics of *Matricaria recutita*. They observed that the sowing time influenced the essential oil content, with values of 0.61%, 0.58%, and 0.57% for the respective sowing dates.

Table 7. Essential oil components (%) for Zloty Lan and Bodegold cultivars according to sowing times

ST	V	Butanoic acid	γ-terpine	Trans β-farnesene	Spathulenol	Bisabolol oxide b	Bisabolone oxide	α-bisabolol	Bisabolol oxide a	Total
1. ST	Z	1.06	0.05	3.35	3.00	2.42	9.38	2.42	65.30	87.2
	B	1.73	0.01	1.79	2.48	2.12	7.54	2.12	70.48	88.3
2. ST	Z	1.93	-	2.74	3.32	2.29	5.59	2.22	68.59	86.7
	B	1.13	-	3.00	3.96	-	6.13	2.30	62.43	79.0
3. ST.	Z	1.39	-	1.42	2.92	2.52	9.24	2.52	66.70	86.7
	B	1.16	-	1.17	3.20	-	17.51	2.28	55.19	80.5
4. ST	Z	1.92	-	1.09	3.13	2.64	10.80	2.64	63.25	85.5
	B	0.9	-	1.52	6.63	-	6.55	2.67	71.87	90.1
5. ST	Z	1.69	-	1.22	3.45	2.38	11.93	2.38	59.83	82.9
	B	1.44	-	1.07	4.20	2.84	9.03	2.84	73.83	95.3

V: Varieties; Z: Zloty Lan; B: Bodegold; ST: Sowing times (October 1, October 15, November 1, November 15 and December 1);

Arslan (2012) also explored the essential oil content of *Matricaria recutita*, focusing on the Bodegold and Zloty Lan varieties. His study has three different sowing times (November 10, November 30, and December 23). Notably, the highest essential oil content (%) was recorded during the third sowing time, with values of 0.56% and 0.64% for Bodegold and Zloty Lan, respectively. However, our study's findings indicated lower essential oil content compared to those reported by Hadi-Seyed et al. (2004) and Arslan (2012). It is plausible that these discrepancies arise from variations in post-harvest storage conditions, handling practices and climatic differences between the studies.

The statistical analysis concluded that the influence of sowing times, varieties and the interaction between sowing time and varieties on essential oil yield (l da^{-1}) was not significant. Table 6 shows that the Zloty Lan cultivar had the highest average essential oil yield at the 3rd sowing period, reaching 0.090 l da^{-1}. In contrast, the Zloty Lan cultivar had the lowest average essential oil yield at the 5th sowing period, with 0.020 l da^{-1}. A study conducted by Hadi-Seyed et al. (2004) examined the effects of various sowing dates (March 5, March 15, and March 25) on the agronomic characteristics of *Matricaria recutita*. The results showed that the essential oil yields as 0.247 l da^{-1}, 0.214 l da^{-1} and 0.183 l da^{-1} respectively.

The percentages of essential oil components for Zloty Lan and Bodegold cultivars according to sowing periods can be found in Table 7. The table highlights the major occurrence of bisabolol oxide a and bisabolone oxide, exhibiting distinct proportions.

When analyzing the main components of the essential oil, it was found that the Zloty Lan cultivar had bisabolol oxide a, values ranging from 59.83% to 68.59%, while the Bodegold cultivar had values ranging from 55.19% to 73.83%. The bisabolone oxide level varied between 5.59% and 11.93% for Zloty Lan and between 6.13% and 17.51% for Bodegold.

Conclusion

This study aimed to identify the optimal chamomile variety and sowing time in Aydın's ecological conditions, assessing yield and quality variations among different varieties. The study encompassed five sowing times (October 1, October 15, November 1, November 15, and December 1) and two varieties (Bodegold, Zloty Lan).

Statistical analyses revealed significant differences in fresh flower yield and essential oil content based on varying sowing times and cultivars. Notably, Zloty Lan exhibited the highest average plant height at 55.2 cm at the second sowing time, while Bodegold displayed the largest flower diameter (27.53 mm) at the fifth sowing time. The maximum fresh herb yield (332.3 kg da^{-1}) was achieved with Zloty Lan at the first sowing time and the highest fresh flower yield (61.61 kg da^{-1}) occurred at the same sowing time. Bodegold, sown at the fifth sowing time, yielded the highest drog herb yield (73.5 kg da^{-1}) and drog flower yield (13.3 kg da^{-1}) for Zloty Lan at 2nd sowing time.

The essential oil content reached its peak value at 0.083% for Bodegold for the earlier sowing period, while Zloty Lan sown at the 3rd sowing time recorded the highest essential oil yield (0.090 l da^{-1}). Predominant essential oil components were bisabolol oxide a and bisabolone oxide. Zloty Lan and Bodegold exhibited bisabolol oxide a values ranging from 59.83% to 68.59% and 55.19% to 73.83%, respectively. Correspondingly, bisabolone oxide values varied from 5.59% to 11.93% for Zloty Lan and 6.13% to 17.51% for Bodegold.

While some values did not show statistical differences, a comprehensive comparison favored Zloty Lan for early sowings (October 15, November 1, November 15) and Bodegold for later sowings (December 1, December 15). Bodegold is superior in terms of essential oil content and bisabolol oxide a, which the primary component for chamomile.

Considering the economic significance of chamomile flowers, essential oil content and essential oil yield, it is recommended to sown Bodegold variety between December 1-15 to maximize essential oil production. Zloty Lan is suggested for optimal results for earlier sowing conditions.

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